METHOD FOR SYNCHRONIZATION IN A MOBILE RADIO TERMINAL

Technical Field of the Invention

The present invention relates to a method for a
mobile radio terminal having dual radio access technology

5   (RAT) capabilities, and more specifically to a method for
providing a common time event, from which the start time of
measurements required according to respective RAT is
determined, and a communication apparatus having such
synchronization capabilities.

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Description of Related Art

Different telecommunication systems using different
technologies are available. GSM (Global System for Mobile
communications) considered as a second-generation

15   communication system is one of the most common and is based
on TDMA (Time Division Multiple Access) radio access
technology (RAT). GPRS (General Packet Radio Service) and
EDGE (Enhanced Data for GSM Evolution) are data
communication techniques for GSM systems, which are also

20   based on TDMA technology. UMTS (Universal Mobile
Telecommunication System) is considered a third-generation
communication system and is based on WCDMA (Wideband Code
Division Multiple Access) RAT. The WCDMA technology may be
used as a stand-alone RAT. 3GPP (third Generation

25   Partnership Project) specifications suggests a dual RAT
communication system, which shall allow mobile terminals to
handle both WCDMA and a second RAT, such as GSM. An
important feature in dual RAT systems is the possibility to
do handover between RATs and to select cell in the RAT that

30   has the best radio environment quality. In order to achieve
this, a dual RAT mobile terminal needs to execute cell
measurements on both RAT systems in addition to
receive/transmit using one of the RATs. When the terminal
is connected to one system being active, measurements on

35   the passive system have to be supported. This is a problem

in case the passive system can not carry out measurements
while the active system is receiving/transmitting.
Simultaneous activities of the systems are problematic when
the systems utilize common radio resources, such as a

5   common antenna. Furthermore, simultaneous activities may
also be problematic when two parallel RAT systems having
separate radio resources are provided. A first of the
parallel systems may interfere with the second RAT system
to such an extent that the second RAT system is unable to

10   provide measurements. In both these cases, the measurements
on the passive system could be carried out when there are
gaps in the reception/transmission of the active system.
The occasions that can be utilized by the passive system
are either determined by the active system or given by the

15   radio access network of the active system.
        There is a problem with providing measurements in a
passive or slave system when it may not be active
simultaneously with the active system, as the time gaps
when the active system is not receiving/transmitting are

20   very short. The passive system has to execute its
measurements during such gaps. Furthermore, the two systems
are not synchronized and may not use the same time format.
Different time formats cause further problems, as is the
case for GSM/GPRS/EDGE and WCDMA. According to GSM

25   requirements, cell measurements have to be provided during
pre-specified occasions that are determined in the GSM time
format. It is not required that the cell measurements
according to WCDMA RAT are executed during a specific time.
WCDMA cell measurements may be executed at practically any

30   time and do not have to be planned in advance, as is the
case for GSM measurements. The time formats of GSM and
WCDMA are different. Therefore, the WCDMA system cannot
simply indicate in its own time format to the GSM system
when the GSM system is allowed to be active and provide

cell measurements, as the GSM system is not capable of interpreting the given gaps.

Summary of the Invention

5   One object of the present invention is to provide a method for providing a time schedule for cell measurements on an active radio access network utilizing a first radio access technology (RAT) and on a passive radio access network utilizing a second RAT, for facilitating e.g.

10   handover and cell selection when the access means may not transmit/receive simultaneously.

         According to a first aspect of the invention, this object is achieved by a method providing synchronization of the time used for cell measurements of a first

15   communication network executed by a first radio access means and the time used for cell measurements of a second network executed by a second radio access means. The first access means utilizes a first RAT, such as WCDMA, whereas the second access means utilizes a second RAT, such as GSM.

20   The first and the second access means may have one radio resource in common, which requires that the first and the second access means are not active simultaneously. Alternatively, the first and second access means have no radio resource in common, but are not allowed to

25   transmit/receive simultaneously. According to the invention, the first access means is normally active and facilitates both communication and measurements, whereas the second access means acts as a slave access means, which only provides cell measurements until handover is made.

30   According to the invention, a time reference common to the first and the second access means is generated. A time schedule common to the first and second access means is obtained, which indicates at least one time gap wherein the first access means is not receiving/transmitting and

35   wherein the second access means is allowed to be active

(receive/transmit). The schedule is determined based on the common time reference.

The common time reference may be generated in response to a time event (CTE) common to the first and second access means. In response to said CTE, the values of counters of the first and second access means, respectively, will be stored in counter value registers connected to the counters. The values of the registers will serve as the values of the time reference, which are expressed in the time format of the respective RAT.

The first access means will determine a measurement gap schedule (MGS) comprising a time schedule defining the duration and location of the gaps with respect to the CTE. The second access means is allowed to be active during said gaps. The MGS will comprise an activation time of the schedule, which is determined in the time format of the first access means and which may be determined based on the time distance from the CTE. When the second access means receives the MGS it may translate it and use the time reference of its registers to determine the activation time in its own time format.

Another object of the invention is to provide an arrangement adapted to provide cell measurements on an active radio access network utilizing a first radio access technology (RAT) and measurements on a passive radio access network utilizing a second RAT.

According to a second aspect of the invention, this object is achieved by an arrangement comprising a first radio access means and a second radio access means. The first access means is adapted to communicate with a first communication network according to a first RAT, whereas the second access means is adapted to communicate with a second communication network according to a second RAT. The arrangement further comprises a time reference generating means for generating a time reference common to the first

and the second access means. A time schedule generating means for obtaining at least one time schedule being common to the first and second access means is adapted to generate a time schedule, which indicates at least one time gap

5   wherein the first access means is not receiving/transmitting and wherein the second access means is allowed to be active. The time schedule generating means is further adapted to determine an activation time of the schedule, which is determined based on the time distance to

10   the common time reference.

The first and second access means may have at least one common radio resource, such as an antenna.

The arrangement may further comprise in each access means a counter for generating counter values, a counter

15   value register for registering counter values, and a counter synchronize mechanism. Either of the mechanisms may be adapted to generate a CTE, in response to which the counter values will be registered in the respective registers. The counter values are expressed in the time

20   format of the respective access means.

The time schedule generating means may further be adapted to incorporate into the time schedule parameters identifying the time gaps, wherein the second access means is allowed to be active, and the activation time of the

25   schedule. The second access means is adapted to translate the MGS to its own time format and determine the activation time by means of the counter values stored in its register.

According to a third aspect of the invention, a computer program product directly loadable into a memory of

30   a mobile terminal having computer capabilities, such as a central processing unit for executing computer software code portions is disclosed. The product comprises software code portions for performing the method according to the invention when said product is run by said terminal.

According to a fourth aspect of the invention, the inventive arrangement is used in a wireless communication apparatus. The apparatus may be a mobile radio terminal, a mobile telephone, a pager, or a communicator, i.e. a personal digital assistant or a smartphone.

One advantage of the invention is that it gives a robust method that can be applied in all different states to transfer occasions for measurements from the active radio access means to the passive access means.

Further embodiments of the invention are defined in the dependent claims.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

Brief Description of the Drawings

Further objects, features, and advantages of the invention will appear from the following description of several embodiments of the invention, wherein various aspects of the invention will be described in more detail with reference to the accompanying drawings, in which:

Fig.1 is a schematic front view of a mobile telephone and the environment in which it operates;

Fig. 2a is a block diagram of access means for a first and a second radio access technology having common radio resources;

Fig. 2b is a block diagram of access means for a first and a second radio access technology having separate antennas;

Fig. 3 is a more detailed block diagram of the access means of Fig. 2a and 2b;

Fig. 4 is a structure diagram showing a compressed mode pattern structure;

Fig. 5 is a timing diagram showing the relationship between the common time event, the activation request and the activation time of the compressed mode pattern of Fig. 4;

Fig. 6 is a flowchart of the steps of a method for the common time event;

Fig. 7 is a flowchart of a first embodiment of the steps of a method for the measurement gap schedule; and

Fig. 8 is a flowchart of a second embodiment of the steps of the method for the measurement gap schedule.

Detailed Description of Embodiments

Fig. 1 illustrates a mobile telephone 1 as a schematic front view and the environment in which it operates. The mobile telephone 1 comprises an antenna 10 mounted on the housing of the apparatus. Alternatively, the mobile telephone 1 may have an internal antenna mounted within the housing of the apparatus. The antenna 10 is electrically connected to a printed circuit board of the mobile telephone 1 through an antenna switch, as will be further described below. The mobile telephone further comprises a display 11, a keypad 12, a loudspeaker 13, and a microphone 14, which together provide a man-machine interface for operating the mobile telephone 1.

The mobile telephone 1 may alternatively have two separate internal or external antennas (se Fig. 2b) antennas, which are adapted to the radio access technology for which they are utilized, as will be discussed below.

The mobile telephone 1 is adapted to establish a first wireless link 15 to a radio station (base station) 16a of a first mobile telecommunication network 17. The mobile telephone 1 is also adapted to establish a second wireless link 18 to a radio station (base station) 19a of a

second mobile telecommunication network 20. Each base
station 16a, 19a serves one or several cells. The first
system 17 utilizes a first radio access technology (RAT),
such as WCDMA (Wideband Code Division Multiple Access) or
5   cdma2000 (Code Division Multiple Access 2000), for
communicating with the mobile telephone 1. The second
system 20 utilizes a second radio access technology (RAT)
other than the first RAT for communicating with the mobile
telephone, such as GSM (Global System for Mobile
10 communications).

The mobile telephone 1 is further adapted to select
whether to utilize the first or the second communication
network 17, 20 for providing communication of e.g. speech
and data depending on the quality of the link 15, 18
15 between the base stations 16a, 19a and the mobile terminal
1. Thus, the mobile telephone has to provide cell
measurements of neighboring cells. As is illustrated in
Fig. 1, the first and the second network comprise several
base stations 16b, 16c, and 19b, 19c, respectively, each
20 serving one or several cells. As the position of the mobile
telephone may change it may come into the vicinity of
another cell, in which better link quality is provided
compared to the one in which the mobile telephone 1 is
located. Either the first or the second network 17, 20 is
25 the active network, whereas the other is the passive or the
slave system. When the mobile telephone 1 experiences
superior link quality from a base station 16a-c, 19a-c,
serving a specific cell not belonging to the active network
17, 20, the network may do handover to the other network.
30 Also, the mobile may provide cell selection between
neighboring cells within the same network. Handover and
cell selection require that the mobile telephone provides
cell measurements of both the active and the passive
network, 17, 20.

The present invention provides a method for
synchronizing the cell measurements of the active and the
passive network when said networks are not utilizing the
same time format. In WCDMA, frame, slot and chip are used
5   as the time format, whereas the time format of GSM is
multiframe and quarter bit.

The mobile telephone 1 may utilize common radio
resources for communication according to the first and the
second RAT. Thus, the antenna 10 is adapted to communicate
10   signals in a first frequency band when the first network 17
is active and communicate signals in a second frequency
band when the second network 20 is active. Communication
using the WCDMA RAT is provided in the 2 GHz frequency
range, whereas communication using the GSM RAT is provided
15   in the 900, 1800, and/or 1900 frequency ranges.

As can be seen in Fig. 2a, the antenna 10 is
connected to an antenna switch 30 for connection to either
access means 100 of the first RAT or access means 200 of
the second RAT, which may be provided as ASIC's
20   (Application Specific Integrated Circuit) on separate
chips. The switch 30 is controlled by a controller 31,
which may be provided as an integrated circuit integral
with the switch 30, or by any central processing unit (CPU)
of the mobile telephone 1, as will be discussed below.

25   Alternatively, each access means 100, 200 has its own
antenna, as can be seen in Fig. 2b. Corresponding
components of Figs. 2a and 2b are denoted with the same
reference numerals. In the embodiment of Fig. 2b, the first
access means 100 is connected to a first antenna 10a, which
30   is adapted to provide signals in at least a first frequency
band, such as in the WCDMA frequency band. The second
access means 200 is connected to a second antenna 10b,
which is adapted to provide signals in at least a second
frequency band, such as a GSM frequency band.

The access means 100, 200, comprise circuitry for
communicating according to their respective technologies.
Each access means 100, 200 comprises an air interface stack
having a physical layer implemented using hardware, and
5   higher layer implemented with software for controlling the
communication. The access means is generally known in the
art and is therefore not further disclosed here, except
when the invention departs from what is generally known.

For convenience, in the following the access means
10 100 adapted according to WCDMA RAT will be denoted WCDMA
RAT 100 and the access means 200 adapted according to GSM
RAT will be denoted GSM RAT 200. However, this should not
be taken as limiting the scope of the invention, but is
only for exemplifying purposes. The first communication may
15 alternatively be a cdma2000 network and the second network
may alternatively be a PCS network.

The switch 30 is in a first position operatively
connected to a physical layer 110 of the air interface
access stack of the WCDMA RAT 100. The WCDMA physical layer
20 110 is controlled by a radio resource controller (RRC)
block 120, which may also control the switch 30. The RRC
block 120 may establish and terminate a connection to the
WCDMA system, as well as initiating cell measurements
required according to system requirements and do handover.
25 In a second position, the switch is operatively connected
to the physical layer 210 of the air interface access stack
of the GSM RAT 200. The GSM physical layer 210 is
controlled by a management physical layer or radio resource
(RR) block 220. The RR block 220 may establish and
30 terminate a connection to the GSM system, as well as
initiating cell measurements required according to system
requirements and do handover. The RR block 220 may control
the switch 30 instead of the RRC block 120. The circuits of
the physical layer of the respective RAT's are connected
35 via a first connection 300 (see Fig. 3) for purposes that

will be described below. Also, a second connection 301 is
provided between the higher layers (layer 2 and layer 3) of
the access stacks of the respective RATs 100, 200, for
providing high level communication, as will be further
5   described below. Each RAT 100, 200 comprises a central
processing unit 130, 230 for executing the functionality of
the software that implements the higher layers of the
access stacks.

        Fig. 3 illustrates a more detailed block diagram of
10   the mobile telephone 1 and components of the two RATs 100,
200. The WCDMA physical layer 110 comprises a transceiver
150 for transmitting and receiving signals according to
WCDMA technology when connected to the antenna 10 via the
switch 30. A timing generator 155, for providing a time
15   reference generating means, is adapted to generate a time
reference in response to a time event in the time format of
the WCDMA RAT. The timing generator 155 may be implemented
as an integrated circuit of the ASIC. The timing generator
155 comprises a counter synchronize mechanism 156, which is
20   adapted to generate a synchronization signal, common time
event (CTE), which will synchronize a counter 158 of the
WCDMA RAT, as will be described below. When the CTE is
generated by the counter synchronize mechanism 156 the
timing generator 155 will store counter values specific to
25   the WCDMA RAT in a counter value register 157. The register
157 is readable from software executed in a CPU 130, which
is specific to the WCDMA RAT 100. A synchronize mechanism
161, e.g. implemented by software instructions run on the
CPU 130 or a separate processor (not shown), is adapted to
30   generate a real time event shared between the RATs 100,
200, which indicates that an activation request to initiate
measurements has been issued. This function will generate
maskable interrupts in both RATs, which will synchronize
the measurement initiation and activate the scheduling of
35   the measurements. A high speed serial link (HSSL) interface

162 for communicating data between the WCDMA RAT 100 and
the GSM RAT 200 is connected to the CPU 130. Parameters for
a measurement gap schedule (MGS) defining the time schedule
will be transmitted via the HSSL 162 over a connection
5   301a, which may be implemented as a serial connection. A
memory 153 is connected to the CPU 130, and may be provided
as a combined random access memory (RAM) and read only
memory (ROM) integrated on the ASIC. The memory 153 may
comprise software code portions for providing computer
10   readable instructions for carrying out software implemented
features of the invention when run by the mobile telephone
1. The CPU 130 may serve as a means for carrying out said
instructions.
        The GSM physical layer 210 comprises transceiver
15   circuitry 250 for exchanging data with the antenna 10 when
the switch 30 is in a second position. Similar to the WCDMA
RAT 100, the GSM RAT 200 comprises a timing generator 255,
for providing a time reference generating means, according
to the same principles as the WCDMA timing generator 155.
20   The timing generator 255 comprises a counter synchronize
mechanism 256, a counter value register 257, and a counter
258. The counter synchronize mechanism 256 is connected to
the counter synchronize mechanism 156 of the WCDMA RAT. A
CPU 230, which is specific to the GSM RAT is connected to
25   the timing generator 255 and the transceiver circuitry 250.
The transceiver circuitry is adapted to provide
communication according to GSM RAT. A synchronize mechanism
261 is adapted to provide synchronization for the
measurement activation and may be implemented by computer
30   readable software instructions executable by the CPU 230 or
a separate processor. The synchronize mechanisms 161, 261
of the respective RAT 100, 200 may exchange data, which is
indicated by a connection 301b. A HSSL interface 262
connected to the GSM CPU 230 is adapted to exchange data
35   with the HSSL interface 162 of the WCDMA RAT 100 over the

connection 301a. A memory 253 is connected to the CPU 230,
and may be provided as a combined random access memory
(RAM) and read only memory (ROM). The memory 253 may
comprise software code portions for providing computer
5   readable instructions for carrying out software implemented
features of the invention when run by the mobile telephone
1. The CPU 230 may serve as a means for carrying out said
instructions.

       Each RAT 100, 200 is in operation required to provide
10   cell measurements on its respective communication network
17, 20. The measurement requirements of the WCDMA RAT 100
when it is active may be measurements on neighboring cells,
inter-frequency measurement, received signal code power,
received signal code power after radio link combination,
15   SIR (Signal-to-Interference Ratio), RSSI (Received Signal
Strength Indicator), etc. Similarly, there are requirements
that the GSM RAT 200 in operation should provide cell
measurements, although it is the passive slave RAT. Such
measurements comprise e.g. RSSI for a number of different
20   neighboring cells, identification measurement, and
reconfirmation measurement. Whenever a cell having superior
radio link quality is found, handover from the active to
the passive network may be made.

       Interrupts for GSM measurements can be provided in
25   three different categories; interrupt during compressed
mode; interrupt during measurement occasions; and interrupt
during measurement DRX cycle. Here, interrupt means a
temporary suspension of an ongoing process caused by an
event outside that process. A number of MGS schedules, as
30   e.g. illustrated in Fig. 4, can be run in parallel. A
request to activate each schedule may be issued separately.
The activation time of each schedule may be determined with
regard to one and the same CTE as illustrated in Fig. 5.
Alternatively, each time schedule will have an activation
35   time that is determined with regard to a specific CTE,

which is independent of the CTE connected to any other time schedule.

The MGS according to the invention is a mechanism comprising time schedule parameters for synchronizing the
5   required WCDMA and GSM measurements when the GSM RAT is passive. The available time gaps, wherein the WCDMA RAT is not receiving/transmitting, are determined and indicated by the WCDMA RAT 100. The WCDMA RAT may be in two different RRC (Radio Resource Control) protocol statuses: Idle mode
10 and UTRAN connected mode. In Idle mode, measurements are provided according to the discontinuous reception (DRX) cycle. The UTRAN connected mode comprises Cell_PCH, Cell_FACH, Cell_DCH and URA_PCH.

In Cell_DCH, a DPCH (Dedicated Physical Channel) is
15 assigned to the user equipment (UE), which may be a mobile telephone 1. The UE has identified the cell level by the current Active Set, which is a procedure for updating the active set of communication parameters of the connection between the UE and the UTRAN. The dedicated transport
20 channel, the downlink-shared transport channel and the combination thereof have also been identified.

In Cell_FACH no DPCH is assigned to the UE. In this state, the UE receives FACH (Forward Access Channel) messages in the downlink, and in the uplink it can use a
25 common channel that can execute transmission from time to time according to access procedures of each transport channel.. UTRAN is aware of the location of the UE at cell level (the cell updated by UE most recently).

In Cell_PCH, URA_PCH and Idle mode, no dedicated
30 channel is assigned to the UE. In the downlink, the UE receives PCH messages via PICH (Paging Indication Channel) by DRX. In the uplink, the UE is not engaged in anything. UTRAN is aware of the location of the UE at UTRAN registration level (the URA (User Registration Area)

assigned most recently to the UE during URA Update in
Cell_FACH state).

When the WCDMA RAT is in idle state the DRX cycle
will control how often and how much the GSM RAT 200 is
5   allowed to operate. In Cell_FACH the gaps are called
measurement occasions in the downlink and some of them are
allocated for GSM use. In the uplink, the mobile telephone
1 may itself determine when to transmit. These gaps will
never be shorter than 1 WCDMA frame and thereby clearly
10   exceed the 14 WCDMA slot maximum gap allocated in
compressed mode. It is required that the GSM system manage
to measure RSSI for 16 different neighboring cells in 10ms,
which gives 652 μs for each carrier that e.g. can be split
into one measure part that is 59 μs (16 GSM symbols) and a
15   tuning part that is 566 μs.

In Fig. 4, wherein the compressed mode pattern
structure is illustrated, the following abbreviations are
used:

	TGSN	Transmission Gap Starting Slot Number;
20	TGL1	Transmission Gap Length 1, duration of the first transmission gap within the TGP (Transmission Gap Pattern) expressed in slots;
25	TGL2	Transmission Gap Length 2, duration of the second transmission gap within the TGP (Transmission Gap Pattern) expressed in slots; if not used in a pattern TGL2=TGL1;
30	TGD	Transmission Gap start Distance, which is the duration between the starting slots of two consecutive transmission gaps within a TGP expressed in slots. If only one TGL is used, this will not be used;

TGPL1	Transmission Gap Pattern Length 1 is the duration of transmission gap pattern length 1 expressed in number of frames;
TGPL2	Transmission Gap Pattern Length 2 is the duration of transmission gap pattern length 2, if used, expressed in number of frames;
TGPRC	Transmission Gap Pattern Repetition Count is the number of transmission gap patterns within the transmission gap pattern sequence
TGCFN	Transmission Gap Connection Frame Number (TGCFN) is the Connection Frame Number (CFN) of the first pattern 1 within the transmission gap pattern sequence.

Fig. 4 illustrates the compressed mode pattern structure wherein reception/transmission gaps may occur. Compressed mode is based on that the radio transmission and reception of the WCDMA signals are turned off during small intervals to allow measurements on GSM neighboring cells. The transmission gaps in the compressed mode structure are referenced to the WCDMA frame and slot structure. When the WCDMA RAT 100 uses compressed mode it will raise the hardest requirements on the GSM radio, as it provides the shortest gaps. The transmission gap length (TGL) can be 3, 4, 5, 7, 10, and 14 WCDMA slots where 3 and 4 are only used for RSSI measurements, 5 is used only when the GSM cell's timing is known; and 7, 10, or 14 are used for previously not identified cells. Corresponding patterns may be provided for measurement occasion and DRX cycle having gaps wherein the WCDMA RAT 100 is not receiving/transmitting.

The transmission gap can be placed in one frame. Alternatively the transmission gap crosses the frame boarder. In order to allow efficient measurements, several

intervals may be placed within a transmission gap pattern
(TGP).

There are three different measurement patterns for
GSM with three different purposes, GSM RSSI measurements,
5   and GSM BSIC identification and reconfirmation. Each
pattern has specific requirements. Therefore, the RR block
220 needs information of the available gaps to be able to
plan the future measurements. Once the gaps are known the
RR block 220 may plan the measurements based on the
10   available gaps.

The effective transmission gap may be smaller than
the TGL due to two factors: the power mask for the uplink
(UL) and the timing offset between the UL and downlink
(DL). The WCDMA transmitter power mask surrounding the
15   compressed mode gap introduces a margin at the start of the
gap and the end of the gap. Since the start of the
transmission gap will be used for radio tuning, the margin
at the start will not affect the dual RAT operation but the
margin at the end will disable the last portion of the
20   transmission gap to be used for dual RAT operation. The
most rigid requirement on the GSM radio tuning is the case
with TGL 14 and GSM RSSI measurements. In order to get some
margin it is preferred to require a radio settling time for
the GSM radio. The margin has to be evaluated and tested
25   for each particular case.

The WCDMA RAT 100 first determines the specific
transmission gaps that are required for its own
measurements. Any remaining transmission gap may be
allocated for measurements made by the GSM RAT 200.
30   Alternatively, the gaps that should be handed over are pre-
specified, wherein the WCDMA RAT 100 has to adapt its
measurements. The WCDMA RAT 100 provides to the GSM RAT 100
the position of the gaps having reference to the CTE, and a
specified activation time. The basic idea is that the
35   activation time of the transmission gap pattern is related

to the latest CTE. Considering that an activation start of
the pattern is related to the CFN (connection frame
number), the request to activate the measurement pattern
needs to be sent down from RRC block 120 to the timing
5   generator 155 of the WCDMA physical layer 110 no more than
one CFN period in advance of the activation start time. One
CFN period corresponds to 25*10 ms. The request to activate
the pattern may serve as the event that initiates the
generation of the CTE and the MGS. Due to that the CTE
10   could be placed at any chip position, the following
parameters need to be registered in the counter value
register 157 of the WCDMA RAT 100 at the time of the CTE:

- The current connection frame number: CFN_{CTE}
  $\in \{0...255\}$
15 - The current slot: $Slot_{CTE} \in \{0...14\}$
    - The current chip: $Chip_{CTE} \in \{0...2559\}$

The CFN is not valid in idle mode, wherein the SFN (cell
System Frame Number) has to be used to calculate the
correct gaps.

20   A measurement activation request may cause a request
for a CTE signal to be sent between the timing generators
155, 255, wherein the counter values will be stored in
their counter registers 157, 257, as will be discussed
below. The values of the WCDMA counter 158 and the GSM
25   counter 258 will be stored approximately simultaneously,
i.e. sufficiently simultaneous for providing a common time
reference, as the RATs 100, 200 may run on asynchronous
clocks. The parameters registered in the GSM RAT 200 are:

- The current frame number (FN) in the GSM
30   multiframe structure $\in \{0...51\}$;
  - The position within the current frame $\in \{0...4999\}$
    [GSM quarter bit (QB)].

Alternatively, the complete representation of the frame
number in the GSM stack is registered, which is in the
35   range of [0...2715647].

In total, three different GSM related compressed mode patterns, or any other pattern where appropriate, should be able to be configured to take care of the different GSM measurement requirements. This requires that the activation

5   start of all three patterns need to refer to the same CTE. The relationship between the CTE, the measurement activation request and the activation time of the compressed mode patterns is illustrated in Fig. 5. Similar patterns may be specified for any other possible pattern,

10   such as Idle mode and measurement occasion patterns. The configuration of activation time can be done for all patterns at once or pattern by pattern. The distance between the CTE and each activation time is denoted as $Chip_{CTE\_active\#\_delta}$, wherein #=1..3 in Fig. 5. The

15   $Chip_{CTE\_active\#\_delta}$ is based on the sum of the distance between the CTE and the CFN when the activation is requested, (CFN_{req}), and the remaining distance between the CFN_{req} and the TGCFN.

     Due to the time delay, which is caused by path drift

20   of the received signals compared to the internal clock of the WCDMA RAT 100, between the channel timing and the counter 158 of the WCDMA RAT 100 a delay term T_{CTE_ALIGN} expressed in chips may be introduced to improve the accuracy of the time schedule, where:

25           $T_{CTE\_ALIGN}=T_{channel\_delay}+T_{CTE}$ [chip];

             $T_{CTE}=Chip_{CTE}-Slot_{CTE}*2560$ [chip]; and

             $T_{channel\_delay}=$path delay $\in\{0...38399\}$ [chip].

     Path delay is the chip timing reference for the

30   downlink DCH. $Chip_{CTE}$ and $Slot_{CTE}$ are the chip and slot, respectively, in which the CTE is executed.

     Each of the distances from the CTE to the activation time expressed in chip may be calculated as:

             $Chip_{CTE\_req\#\_delta}=$ $T_{CTE\_ALIGN}+(REP_{256}+mod_{CFN}(CFN_{req}-$

35   $CFN_{CTE},256))*15*2560$;

$$\text{Chip}_{\text{req\_active\#\_delta}} = \text{mod}_{\text{CFN}}(\text{TGCFN} - \text{CFN}_{\text{req}}, 256)) * 15 * 2560$$

$$\text{Chip}_{\text{CTE\_active\#\_delta}} = \text{Chip}_{\text{CTE\_req\#\_delta}}$$

$$+ \text{Chip}_{\text{req\_active\#\_delta}} + \text{TGSN} * 2560;$$

where mod_{CFN} is a modulo 256 function and REP_{256} is the
5   counter 158 of the WCDMA RAT 100 that starts at 0 and is
updated each time the CFN is equal to the CFN_{CTE} . As the
first activation request is made before the CTE, the CFN_{req}
shall be set to CFN_{CTE} for the calculation of the first
distance $\text{Chip}_{\text{CTE\_activl\_delta}}$.

10   The counter parameters in the WCDMA RAT 100 are
expressed in WCDMA time format, whereas the counter
parameters in the GSM RAT 200 are expressed in GSM time
format. The WCDMA RAT 200 is the active RAT, and therefore
all arithmetic operations should be made in chips to avoid
15   summation and truncation errors. Therefore, it is necessary
for the GSM RAT 200 to convert the values of the parameters
determined by the WCDMA RAT 200 into QB, which is made by
multiplying each parameter with the quota 325/1152.

The parameters of the MGS will define a common time
20   schedule for providing the GSM and WCDMA measurements, and
may comprise:

Schedule ID (SI) $\in \{1...6\}$:

This parameter identifies the schedule, which will be
needed in those situations when more than one schedule are
25   active simultaneously. The value for this parameter is
given by the Transmission Gap Pattern Sequence Identifier
(TGPSI $\in \{1...6\}$ in compressed mode). In other states there
will only be one schedule running at the same time, i.e.
one value for the SI.

30   **Schedule Start Time (SST)** $\in \{0...2^{32}-1\}$ [chip]:

This parameter sets the activation time for a
schedule in relation to the common time reference that is
shared between the WCDMA RAT 100 and the GSM RAT 100 as a
common time event (CTE). SST is pointing at the first gap
35   occurrence, as is indicated in Fig. 4. The 32-bit range

permits a time range up to 18 minutes and 38 seconds. This
range is, however, for exemplification and has to be tested
and evaluated in each particular case.

Schedule Transmission Gap Pattern Length 1 and 2

5   (STGPL1 and STGPL2) $\in \{0...19660800\}$ [chip]:

STGPL1 sets the distance between the starting point
of TG1 in pattern 1 and pattern 2 (or STGPL1 in the next
pattern if no pattern 2 is defined). STGPL2 sets the
distance between the starting point of TG1 in pattern 2 and

10   pattern 1. The sum of these two parameters is the cyclic
length of the schedule. If STGPL2 is assigned 0, there is
only one pattern that is repeated. The values for these
parameters are given by the TGPL in compressed mode (1...144
WCDMA frames). The distance between two measurement

15   occasions that are assigned for GSM measurements called
measurement period (80...640 ms if there are no inter-
frequency neighbors and 160...1280 ms if there are inter-
frequency neighbors) and inter RAT measurement periods
during the DRX cycle (80 ms to 5.12 s) is calculated by

20   WCDMA physical layer 110 in idle, Cell_PCH and URA_PCH.
This gives a range from 0 to 19660800 chip (DRX 5.12 s has
to serve as upper limit – twice the length can be achieved
if combining STGPL1 and STGPL2).

Schedule Transmission Gap Length 1 and 2 (STGL1 and

25   STGL2) $\in \{0...19660800\}$ [chip]:

These parameters set the length of the gaps given by
the schedule for GSM to measure in. The values for the
parameters are given by the transmission gap lengths (TGL)
in compressed mode (3, 4, 5, 7, 10 and 14 WCDMA slots), the

30   length of the measurement occasions (1, 2, 4, and 8 WCDMA
frames) or the inter RAT measurement periods during the DRX
cycle (80 ms to 5.12 s) calculated by WCDMA physical layer
110 in Idle Cell_PCH and URA_PCH. This gives a range from 0
chips to 19660800 chips (DRX 5.12 s serves as upper limit

35   since a complete DRX cycle will never be handed over to

GSM). If STGL is assigned 0, a gap does not exist, which may be the case for STGL2.

Schedule Transmission Gap start Distance (STGD)
$\in \{0...19660800\}$ [chip]:

5   This parameter sets the distance between the starting points for STGL1 and STGL2. The parameter is only valid if STGL2 is greater than 0. The value for this parameter is given in compressed mode by the parameter TGD that is in the range 15...269 WCDMA slots. In measurement occasions and

10   in the inter RAT measurement periods during the DRX cycle maximum STGPL will serve as upper limit, i.e. 19660800 chips. If there is only one gap during the pattern defined by STGPL, then STGD is set to 0.

The values of the MGS when the WCDMA RAT 100 is in

15   Cell_DCH may be determined as:

SI	TGPSI $\in \{1..6\}$ (Transmission Gap Pattern Sequence Identifier;
SST	Chip$_{CTE\_active\_delta}$+1024 (adjustment for UL-DL time difference);
STGPL1	TGPL1*2560;
STGPL2	TGPL2*2560;
STGL1	TGL1*2560-2048 (adjustment for receiver-transmitter timing difference and UL-DL time difference; adjustment is not necessary in e.g. downlink compressed mode);
STGL2	TGL2*2560-2048 (adjustment for receiver-transmitter timing difference and UL-DL time difference; adjustment is not necessary in e.g. downlink compressed mode); and
STGD	TGD*2560.

In Cell_FACH the corresponding MGS parameters may be

35   determined as:

SI	1 [no unit] (constant value since only one schedule will be active at the same time in this state);
SST	$Chip_{CTE\_active\_delta}$;
STGPL1	0;
STGPL2	0;
STGL1	N*2560*15;
STGL2	0; and
STGD	0.

Finally, in idle state the MGS parameters can be determined as:

SI	1 [no unit] (constant value since only one schedule will be active at the same time in this state;
SST	Distance from CTE to first occasion of the MGS schedule;
STGPL1	According to the periods given by the DRX periods
STGPL2	0 (can be used (i.e. not zero) if several gaps need to be defined during one cycle in the schedule);
STGL1	According to planning (based on the DRX periods) performed by the active RAT;
STGL2	0 (can be used (i.e. not zero) if several gaps need to be defined during one cycle in the schedule); and
STGD	0 (can be used (i.e. not zero) if several gaps need to be defined during one cycle in the schedule).

The CTE which is used to synchronize common time reference of the MGS may be provided by a hardware supported interrupt, i.e. an event caused by an external device which interrupts the ongoing process in the active

RAT. The interrupt will call for the counter values to be
stored in the counter value registers 157, 257.

Fig. 6 illustrates the steps according to one
embodiment of the invention for providing the interrupt by
5   issuing the CTE and storing the counter values in response
thereto, which provides a common time reference. In a first
step 400, it is detected by the controller 130 of the WCDMA
physical layer 100 that there is a need for
synchronization, i.e. a CTE is needed. An activation
10   request to start a specific measurement pattern from the
network may initiate the CTE procedure. Alternatively, the
RRC block 120 may (on its own request, e.g. according to
instructions which control the operation of said RRC block
120) initiate an activation of the synchronization. The
15   need may be initialized by software run by the controller
130, which will transmit a request for a CTE to the
synchronize mechanism 161 of the WCDMA 100. Said
synchronize mechanism 161 will then in step 401 issue a
synchronization request, which is transmitted to the GSM
20   synchronize mechanism 261. If the GSM access means is run
on an internal clock, in a clock evaluation/reconfiguration
step 402 a request for an external clock reference will be
issued. The external clock reference is necessary if it is
required that the timing generator 255 of the GSM RAT 200
25   have to clock the counter 258 and the counter value
register 257 from an external clock to achieve sufficient
accuracy and not store erroneous values. An external clock
(not shown), such as an voltage controlled oscillator, may
serve as the external clock reference, which will clock the
30   counter 258 and register 257 of the GSM RAT 200, and the
WCDMA RAT 100 whenever appropriate. Step 402 may be omitted
in alternative embodiments of the invention, wherein the
external clock reference is not required. In step 403 the
CTE is generated by the counter synchronize mechanism 256
35   of the GSM RAT 200. The CTE is e.g. generated by writing a

bit in the HW interface between the GSM RAT 100 and the
WCDMA RAT 100. The CTE is in step 404 communicated e.g.
over line 300. In step 405 the CTE is received by the
counter synchronize mechanism 156 of the WCDMA RAT 100,
5   wherein the CTE interrupt is served in that the counter
values are registered. The values are registered
approximately simultaneously and stored in the respective
counter value registers 157, 257, thus generating the
common time reference.

10   In an alternative embodiment, the WCDMA timing
generator 155 will generate the CTE. If it is not required
that either of the RATs 100, 200, are clocked from an
external clock reference, it is not necessary to involve
the synchronize mechanisms 161, 261. Either of the timing
15   generators 150, 250 may then issue the CTE.

        Step 402 provides the possibility for the GSM RAT to
wake up and reconfigure its internal clocks against the
external clock reference whenever needed.

        Fig. 7 illustrates the steps carried out according to
20   the invention when interrupts are provided during
compressed mode or measurement occasions, i.e. when the
WCDMA RAT is in Cell_DCH or Cell_FACH. The MGS is utilized,
as the GSM RAT 100 has to plan measurements in advance.
Then, the GSM RAT 100 is able to start the correct
25   measurement as soon as the GSM radio is switched on and the
WCDMA transceiver 150 is switched off. The synchronization
procedure will e.g. start at power on if the WCDMA stack is
active. Alternatively, the procedure starts if the active
state of the WCDMA RAT 100 is changing or in response to a
30   resynchronization request from the RRC block 120. The start
of the procedure will establish measurement synchronization
between the GSM and WCDMA RAT 100, 200 and possibly
initiate CTE generation. The procedure will be ended when
the WCDMA access stack enters into a passive state or into
35   a power off state, or the state is changed.

The method of Fig. 7 is started in step 500, wherein
a measurement configuration request is received by the
mobile telephone 1 from the WCDMA telecommunication network
17, to which the WCDMA RAT presently is connected. The
5   configuration request comprises any information necessary
to determine the MGS, such as which gaps that may be used
by the WCDMA RAT 100 and the GSM RAT 200, respectively. The
measurement configuration data, i.e. compressed mode
pattern or FACH measurement occasion is stored in step 501,
10   and may be retrieved by the RRC block 120, which will plan
the measurements of the WCDMA RAT 100. In step 502 the
activation time of the time schedule is determined. The
activation time is in Cell_DCH set by the WCDMA
telecommunication network 17, whereas the activation time
15   in Cell_FACH is obtained by the WCDMA physical layer 110,
e.g. by the CPU 130, based on information received from the
UTRAN. In step 503 the transmission gaps, which may be
utilized by the GSM RAT 200, are determined. The gaps,
which may be utilized by the GSM RAT 200, are in compressed
20   mode given in the measurement configuration data. In
Cell_FACH measurement occasions the transmission gaps are
divided between the WCDMA RAT 100 and the GSM RAT 200, e.g.
according to the 3GPP specification. The CPU 130 determines
based on the received information, which gaps should be
25   utilized for WCDMA RAT measurements, such as inter-
frequency measurements, and which gaps should be utilized
for GSM measurements. In step 504, the parameters of the
MGS are obtained. The activation time and the parameters
that will be handed over to the GSM RAT 100 are translated
30   into MGS parameters. The parameters of the time schedule
are determined based on the common time event CTE, which is
issued in response to the activation request of the time
schedule prepared in the current step. The MGS parameters
including the activation time are forwarded to the GSM RAT
35   in step 505. The GSM RAT 200 receives the MGS parameters in

step 506, and translates said parameters into GSM time
reference in step 507. In step 508 the planning of the GSM
measurements commences, which is also the end of the
procedure. The GSM measurements executed by GSM physical
5   layer 210 may now start according to the activation time
given in the MGS schedule and is e.g. controlled by the RR
block 220 using said schedule.

Fig. 8 illustrates an alternative embodiment of the
steps carried out according to the method of the invention
10   when interrupts are provided during DRX measurement cycle,
i.e. when the WCDMA RAT is in idle, in Cell_PCH, or URA_PCH
state. The procedure is started at power on of the mobile
telephone 1 if the WCDMA access stack is active, if any
WCDMA active state is changing, or if a resynchronization
15   is requested. The WCDMA physical layer 110 may initiate the
synchronization procedure for the MGS method in order to
establish synchronization. In a first step 600, the RRC
block 120 receives information from the WCDMA network 17 to
be able to plan the measurements, such as DRX cycle length
20   and any setup/reconfiguration message. In step 601 the
WCDMA physical layer 110 plans for the DRX measurement
cycle, i.e. determines which gaps should be utilized for
WCDMA RAT and GSM RAT measurements, respectively. A
requested activation time is also determined. In step 602
25   the parameters determined in step 601 are translated into
MGS format having reference to a specific CTE. Inter RAT
measurement rules, which are known to the WCDMA RAT 100 and
which were taken into account when the MGS schedule was
obtained, determine when GSM measurements are to commence.
30   In step 603 the RRC block 120 checks whether the GSM RAT
200 shall measure within a predetermined time limit. If so,
the MGS schedule is forwarded to the GSM RAT in step 604.
Otherwise, the procedure waits in step 603 until a GSM
measurement is to commence or the procedure is ended.
35   Alternatively, the time schedule is directly handed over to

the GSM RAT 200 as soon as it is obtained. The GSM RAT 200
receives the MGS parameters including a start time for the
schedule in step 605. The MGS parameters are translated
into GSM reference time in step 606. The RR block 220 may
5   start planning for the GSM measurements in step 607,
wherein the WCDMA RAT 100 and the GSM RAT 100 have
knowledge of when to execute measurements according to the
obtained MGS.

One difference for the common timing between the idle
10   mode and Cell_DCH or Cell_FACH is that the time references
for the different RATs 100, 200 are not locked to each
other. This requires that the MGS has to be resynchronized
continuously.

The WCDMA physical layer 110 will start the execution
15   of the measurement patterns, i.e. compressed mode patterns,
FACH measurement occasions, or DRX measurement cycle, and
may handle the common radio resources, such as the switch
30 and the antenna 10, according to the MGS schedule. The
GSM physical layer 210 executes its measurements according
20   to the MGS schedule and will have control over the common
radio resources during these measurements when the WCDMA
transceiver 150 is temporarily inactive. Alternatively,
when separate antennas 10a, 10b are provided no control
over the radio resources is necessary, but simultaneous
25   activation (transmission/reception) of the WCDMA RAT 100
and the GSM RAT 200 is avoided by means of the WCDMA and
GSM physical layer 110, 210 having knowledge of the MGS
schedule.

The RR block 220 will control the measurements at GSM
30   physical layer 210 using MGS schedule. The measurements are
scheduled according to the starting time given by the MGS
schedule. In idle state the source of the MGS is DRX
measurement. The RRC block 120 will request input
information for the MGS schedule from WCDMA physical layer
35   110, since the WCDMA physical layer 110 is executing the

planning of the activities during the cycle to be able to control the measurements.

The GSM radio transceiver 250 may be active immediately when the WCDMA radio transceiver 150 has been

5   switched off. To ensure that the WCDMA transceiver has been completely switched off before the GSM transceiver 250 is activated a first time margin may be added after the WCDMA transceiver 150 is switched off. Similarly, a second time margin may be added when the GSM transceiver 250 is

10 switched off and the WCDMA transceiver is activated. During the first time margin, the switch 30 may be controlled to switch from the first to the second position. The WCDMA CPU 130 may e.g. control the switching of the switch 30 from the first position, wherein the WCDMA transceiver 150 is

15 connected to the antenna 10, to the second position when the WCDMA transceiver 150 is properly switched off. Similarly, the GSM CPU 230 may control the switch 30 to switch from the second to the first position when the GSM transceiver 250 is properly switched off.

20   The WCDMA physical layer 110 is adapted to detect a number of situations wherein the GSM RAT measurements are to be interrupted, which creates a MGS exception. Such exceptions are e.g. during altering state (leaving Cell_FACH), RACH (Random Access CHannel) procedure, BCH

25 (Broadcast CHannel) reading due to paging, SFN (cell System Frame Number), (BCH) reading on neighbors in Cell_FACH and Cell_DCH, compressed mode patterns ends (TGPRC parameter in compressed mode, colliding compressed mode patterns, and state transition, i.e. transition between idle, Cell_PCH,

30 and Cell_FACH). The exceptions are preferably detected by the WCDMA RAT 100, as it is the active RAT requiring the exceptions. In all exceptions, the GSM RAT 100 is notified by an exception interrupt signal, which indicates that GSM measurements should be discontinued, wherein all ongoing

35 measurements are stopped. As soon as the exception is taken

care of by the WCDMA RAT 100, the GSM RAT 200 may be
informed that GSM measurements may be resumed. In such a
case, stored MGS parameters may be utilized for the resumed
measurements. The stored parameters may have to be

5　evaluated to secure their validity. The time range for the
MGS may have expired, wherein a resynchronization has to be
provided. Alternatively, a resynchronization of the RATs
100, 200 is always executed after an exception has been
taken care of.

10　　　　The MGS procedure according to any of the above
embodiments is completely stopped when the WCDMA access
stack e.g. enters into a passive state, or is switched off.
　　　　The present invention has been described above with
reference to a mobile telephone. However, the invention may

15　be provided in any portable radio communication equipment,
such as a mobile radio terminal, a pager, or a
communicator, i.e. an electronic organizer, smartphone or
the like having dual RAT capabilities.
　　　　The present invention has been described above with

20　reference to specific embodiments. However, other
embodiments than the above described are equally possible
within the scope of the invention. Different method steps
than those described above, performing the method by
hardware or software, may be provided within the scope of

25　the invention. The different features and steps of the
invention may be combined in other combinations than those
described. The invention is only limited by the appended
patent claims